(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : 0 378 259 B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification : 24.08.94 Bulletin 94/34

(51) Int. Cl.[5] : H01B 7/34

(21) Application number : 90200017.3

(22) Date of filing : 04.01.90

(54) High-voltage connection wire.

(30) Priority : 10.01.89 NL 8900044

(43) Date of publication of application : 18.07.90 Bulletin 90/29

(45) Publication of the grant of the patent : 24.08.94 Bulletin 94/34

(84) Designated Contracting States : DE FR GB IT NL

(56) References cited :
US-A- 4 310 597
ENCYCLOPAEDIA OF POLYMER SCIENCE AND ENGINEERING, publ. WILEY, 1986, Vol. 17, p. 835 and Vol. 6, pp. 522-526
ENCYCLOPAEDIA OF PVC, Ed. Nass,publ. Marcel Dekker Inc., New York,1977, pp.1713-1717

(73) Proprietor : N.V. Philips' Gloeilampenfabrieken
Groenewoudseweg 1
NL-5621 BA Eindhoven (NL)

(72) Inventor : Van Buggenum, Peter Hubertus
c/o INT. OCTROOIBUREAU B.V.
Prof. Holstlaan 6
NL-5656 AA Eindhoven (NL)

(74) Representative : Weening, Cornelis et al
INTERNATIONAAL OCTROOIBUREAU B.V.,
Prof. Holstlaan 6
NL-5656 AA Eindhoven (NL)

EP 0 378 259 B1

Jouve, 18, rue Saint-Denis, 75001 PARIS

Description

The invention relates to a high-voltage connection wire for use in display devices such as, in particular, TV receivers and monitors for computers.

The known high-voltage connection wires comprise an insulating sheath which is provided about the central conductor, said sheath being manufactured from polyethylene which, if desirable, is made to be flame-extinguishing by the addition of additives such as a bromine compound, crosslinked polyethylene, polyvinyl chloride, irradiated polyvinyl chloride, tetrafluoroethylene, polyvinylidene fluoride, copolymer of ethylene and tetrafluoroethylene or silicone rubber.

Both the electrical and the mechanical properties of the special high-voltage connection wires mentioned above must meet high requirements as regards, for example, the flame-extinguishing character, temperature resistance, moisture resistance, flexibility, permissible voltage and variation of the permissible voltage as a function of the stress present or developed in the wire. Since the wires, as stated above, are applied in displays which are used indoors in very large numbers, international research institutes keep a close check on the quality of the connection wires, both when a novel type of wire is introduced and in the subsequent period of use. It should be kept in mind that the connection wires in said display devices bring about the electric connection between the high-voltage unit and the display tube present therein. The temperature may vary substantially in this type of apparatus; besides, the wires must be passed between a variety of components, so that sharp curves are formed which bring about mechanical stress in the connection wire.

The fluorine-containing insulation materials used so far have the advantage of a favourable temperature resistance but they are very expensive. The same applies to the crosslinked polyethylene used which is very expensive owing to the additional and labour-intensive crosslinking operation. Moreover, polyethylene is anything but flame-extinguishing or fire-retardant. The polyvinyl chloride insulation material used has a low temperature resistance.

The above mentioned problems are solved by means of the connection wire according to the invention, in which the conductor is surrounded by a first insulation sheath having a thickness between 0.3 and 1.5 mm and comprising a copolymer of propene and at least one other alkene, said first insulation sheath being coated with a non-crosslinked second insulation sheath having a thickness between 1.0 and 3.0 mm and comprising polyvinyl chloride or a copolymer thereof, said second insulation sheath being further provided with flame-extinguishing additives.

The high-voltage connection wire according to the invention is of exceptional quality and is completely safe for use. The connection wire is, in particular, highly resistant to varying climatological conditions such as temperature, humidity and the like. A relatively high electric voltage load is permissible for a long period of use and at varying mechanical stresses as a result of bending. The first insulation sheath is important to obtain suitable dielectric properties. In particular, the first insulation sheath provides a sufficient insulation resistance.

United States Patent US-4310597 discloses a low-voltage electrical wire consisting of an electrical conductor which is successively coated by an inner layer of polyolefin insulating material and an outer layer of irradiation-crosslinked insulating material made essentially of polyvinyl chloride, acrylic monomers and plasticiser, the combined thickness of the inner and outer layers being around 0.2 mm. The disclosed wire is intended for use in low-voltage telecommunications equipment, where a plurality of such wires are interwoven over tortuous paths, and are very frequently re-routed, kinked, and abraded during routine maintenance work. It is therefore essential that such a wire has a high mechanical resilience, and it is for this reason that the outer insulating layer is hardened by a crosslinking process. The attendant stiffening effect of such crosslinking is disadvantageous, but the relatively small thickness of the outer insulating sheath counteracts such stiffening in the case of a low-voltage wire. However, in the case of a high-voltage rendition of the disclosed wire structure, with substantially thicker insulation layers (minimum combined layer thickness 1.3 mm), this stiffening effect would be much more drastic, and the considerable expense and labour intensiveness of the crosslinking operation would be far greater.

In experiments leading to the invention it was found that a connection wire comprising a first insulation sheath of polypropylene has a favourable insulation resistance in the straight condition of the wire. Tests have been carried out using connection wires comprising a tin-plated copper conductor having a diameter of 0.8 mm and a first insulation sheath of polypropylene. The layer thickness of the first insulation sheath differs, the diameter of the first insulation sheath being 1.9 mm; 2.1 mm and 2.3 mm, respectively. It has been found, that such connection wires can suitably be used with voltage loads of 20 kV, 30 kV and 40 kV, respectively, at temperatures up to 105°C. However, these values apply to a straight connection wire. If the connection wire is bent to a radius of curvature which is approximately 10 times the wire diameter or less, the permissible voltage load is reduced by 40-60%. If polypropylene is substituted by a copolymer of polypropylene and at least one other alkene, bending and, hence, mechanical tensile stress, does not lead to a reduction of the voltage load.

Consequently, also when the wire is bent, a voltage load of at least 20 kV,30 kV and 40 kV, respectively, is permissible for the above-mentioned diameters of the first insulation sheath of the high-voltage connection wire.

In other experiments, connection wires according to the invention were bent substantially at increased temperatures and subjected to an additional mechanical tensile stress. Even under such extreme conditions, the connection wire according to the invention remains suitable for a high voltage load. Also at an increased temperature and under tensile stress, a connection wire according to the invention comprising a conductor having a diameter of 0.8 mm, a first insulation sheath having a diameter of 1.9 mm and a non-crosslinked second insulation sheath having a diameter of 3.2 mm, can be used at a voltage of at least 30 kV. A similar wire comprising the same conductor, a first insulation sheath with a diameter of 2.1 mm and a non-crosslinked second insulation sheath with a diameter of 3.5 mm can suitably be used for a voltage load of at least 45 kV at an increased temperature and under mechanical stress. A service voltage of at least 60 kV is obtained by means of a high-voltage connection wire according to the invention, which comprises a conductor with a diameter of 0.8 mm, a first insulation sheath with a diameter of 2.3 mm and a non-crosslinked second insulation sheath with a diameter of 4.2 mm.

The copolymer is, for example, a copolymer of propene and butene or of propene and hexene. A very suitable copolymer is the copolymer of propene and ethene. Both block copolymers and random copolymers can be used. Preferably, the ethene content is 2-60% by weight. In the case of block copolymers the ethene content is preferably 10-30% by weight. In the case of random copolymers the ethene content is preferably 2-40% by weight. The durability of the copolymer can be extended by adding auxiliary agents such as stabilizers, antioxidants and similar additives in a customary manner.

Further details relating to the advantageous mechanical and insulating properties of propeneethene polymers can be found in the Encyclopaedia of Polymer Science and Engineering, (Wiley and Sons Inc., Canada), volume 17, page 835 (1985).

The non-crosslinked second insulation sheath of the high-voltage connection wire according to the invention ensures that the connection wire has a flame-extinguishing character. The polymer basic material of the second insulation sheath is polyvinyl chloride or a copolymer of vinyl chloride. A suitable copolymer is the copolymer of vinyl chloride and ethylene vinylacetate. Alternatively, for example, a mixture of polyvinyl chloride and another polymer substance can be used such as, for example, a mixture of polyvinyl chloride and polyethylene vinylacetate. Polyvinyl chloride or a copolymer thereof already has fire-retardant properties in itself. This can be attributed to the HCl gas formed when polyvinyl chloride is decomposed, said gas preventing or strongly hampering the oxygen supply, so that the progress of the fire is retarded. In order to obtain a satisfactory flame-extinguishing character, the material of the second insulation sheath is additionally provided with flame-extinguishing additives which are known per se such as bromine compounds, in particular aromatic bromine compounds, for example, decabromine diphenyl or decabromine diphenyl oxide. Alternatively, inorganic oxides or sulphides can be used such as antimony oxide or antimony sulphide. Further, the second insulation sheath may be provided with customary additives such as a filler, for example, calcium carbonate, stabilizers, antioxidants and lubricants.

The flame-extinguishing properties are established in the so-called vertical-wire flame test. In this test, a Tirrill gas burner is used (a Bunsen burner in which the gas and air supply can be adjusted) as well as a metal housing comprising three wall portions, i.e. a bottom plate and two parallel side plates which are arranged perpendicularly on the bottom plate. A specimen of the high-voltage connection wire to be investigated is arranged in the centre of the housing, perpendicularly to the bottom plate and equidistantly from the side plates. The Tirrill gas burner is directed at the specimen, such that the fire tube of the burner is at an angle of 20° to the vertically arranged specimen. Said specimen is subjected to a flame process in which it is heated by the gas flame of the Tirrill burner for 5 periods of 15 seconds each. These active periods are alternated with rest periods of 15 seconds also, during which no heating takes place. The gas flame has a length of 100-125 mm and has a blue, conical flame zone having a length of 38 mm. The temperature at the tip of the blue conical flame zone is approximately 800° C. The tip of said blue flame zone touches the specimen. After the last active heating period, it was found that the specimen stopped flaming within one minute. Moreover, in the test period, no glowing or flaming particles have formed and/or come off the specimen.

If desirable, the high-voltage connection wire according to the invention can be provided with one or more reinforcement layers which are applied to the second insulation sheath, such as a layer of a metal braid which in turn is covered with a PVC sheath.

The invention will be explained by means of an exemplary embodiment and with reference to the accompanying drawing, in which the Figure is a cross-sectional view of a high-voltage connection wire according to the invention.

In the Figure, reference numeral 1 denotes a conductor. Said conductor is manufactured from, for example,

Cu or Cu provided with a layer of Sn. The diameter of the conductor is not of essential importance. A suitable diameter ranges from, for example, 0.5 to 1.5 mm. The conductor may be solid or composed of a number of interwoven elementary wires, a so-called litz wire. A first insulation sheath 2 is provided around the conductor 1. A suitable method for doing this is an extrusion process. The thickness of the sheath 2 is determined by the voltage required during operation of the connection wire. Thus, the thickness may vary between, for example, 0.3 and 1.5 mm for service voltages of 10 kV to, for example, 100 kV or higher. The insulation sheath is manufactured from a copolymer of propene and ethene containing 20% by weight of ethene.

A non-crosslinked second insulation sheath 3 is provided around the first insulation sheath 2 by means of an extrusion process. The sheath 3 provides the high-voltage connection wire with flame-extinguishing properties. The thickness of the sheath 3 is adapted and attuned to that of the sheath 2, in such a manner that a larger layer thickness of sheath 2 leads to a larger thickness of sheath 3. A suitable layer thickness ranges from 1.0 to 3.0 mm. The sheath 3 has the following composition:

50% by weight	PVC-EVA copolymer (Vinnol T.M.)
0.5% by weight	lubricant (montanic acid-ester)
5% by weight	stabilizer (dibasic lead phthalate)
1% by weight	antioxidant (pentaerythrityl-tetrakis [3-(3,5-di tert.butyl-4-hydroxyphenyl)-propionate] (Irganox T.M.)
10% by weight	Sb_2O_3
12.5% by weight	decabromine diphenyl
21% by weight	$CaMg(CO_3)_2$

Claims

1. A high-voltage connection wire for use in display devices, which connection wire comprises an insulated conductor (1), characterised in that the conductor is surrounded by a first insulation sheath (2) having a thickness between 0.3 and 1.5 mm and comprising a copolymer of propene and at least one other alkene, said first insulation sheath being coated with a non-crosslinked second insulation sheath (3) having a thickness between 1.0 and 3.0 mm and comprising polyvinyl chloride or a copolymer thereof, said second insulation sheath being further provided with flame-extinguishing additives.

2. A high-voltage connection wire as claimed in Claim 1, characterised in that the first insulation sheath (2) comprises a copolymer of propene and 2-60% by weight of ethene.

3. A high-voltage connection wire as claimed in Claim 1 or 2, characterised in that the second insulation sheath (3) comprises a copolymer of vinyl chloride and ethylene vinylacetate or a mixture of polyvinyl chloride and polyethylene vinylacetate.

Patentansprüche

1. Hochspannungsverbindungskabel für die Verwendung in Display-Vorrichtungen, wobei das Verbindungskabel einen isolierten Leiter (1) umfaßt, dadurch gekennzeichnet, daß der Leiter von einem ersten Isoliermantel (2) mit einer Dicke von 0,3 bis 1,5 mm umgeben ist, der ein Copolymer von Propen und wenigstens einem anderen Alken enthält, wobei der erste Isoliermantel von einem nicht querverketteten zweiten Isoliermantel (3) mit einer Dicke von 1,0 bis 3,0 mm umgeben ist und Polyvinylchlorid oder ein Copolymer davon enthält und wobei der zweite Isoliermantel außerdem mit flammlöschenden Additiven versehen ist.

2. Hochspannungsverbindungskabel nach Anspruch 1, dadurch gekennzeichnet, daß der erste Isoliermantel (2) ein Copolymer von Propen und 2-60 Gewichtsprozent Äthen enthält.

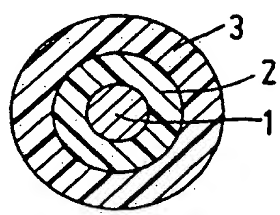
3. Hochspannungsverbindungskabel nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der zweite Isoliermantel (3) ein Copolymer von Vinylchlorid und Äthylenvinylacetat oder eine Mischung aus Polyvinylchlorid und Polyäthylenvinylacetat enthält.

Revendications

1. Fil de connexion à haute tension qui s'utilise dans des dispositifs de visualisation, ledit fil de connexion comporte un conducteur isolé (1), caractérisé en ce que le conducteur est entouré d'une première gaine d'isolation (2) présentant une épaisseur comprise entre 0,3 et 1,5 mm et comportant un copolymère de propène et au moins un autre alkène, ladite première gaine d'isolation étant revêtue d'une deuxième gaine d'isolation non réticulée (3) présentant une épaisseur comprise entre 1,0 et 3,0 mm et comportant du chlorure de polyvinyle ou un copolymère dudit chlorure, ladite deuxième gaine d'isolation comportant encore des additifs pour éteindre les flammes.

2. Fil de connexion à haute tension selon la revendication 1, caractérisé en ce que la première gaine d'isolation (2) comporte un copolymère de propène et d'éthène dont la teneur en poids est compris entre 2 et 60%.

3. Fil de connexion à haute tension selon la revendication 1 ou 2, caractérisé en ce que la deuxième gaine d'isolation (3) comporte un copolymère de chlorure de vinyle et de vinylacétate d'éthylène ou un mélange de chlorure de polyvinyle et de vinylacétate de polyéthylène.


3
2
1